

### **ABSTRACT**

Double-sided, single-sided and ring electrode mesa resonators are provided that operate in the difficult 3 GHZ frequency with an electrode-free resonator area that serves as an energy-trapping area. The double-sided electrode-free resonator device is a double-sided mesa resonator plate, top and bottom wells, a mesa, and top and bottom electrodes deposited in such a way that the electrodes cover the plate surface and surround the mesa, which allows the mesa to protrude above the electrodes and provide an electrode-free resonator area. The top and bottom electrodes, which are acoustically coupled and controlled by acoustic gaps, create an electromagnetic field and an excitation voltage within a vibrating area of the resonator plate generates an acoustic energy which is trapped within the resonator area and confined to the resonator area to minimize a leakage of the acoustic energy and provide a high Q factor at 3GHz. The resonator has a resonator frequency determined by a resonator thickness dimension,  $t_3$ , influences the resonator area's ability to function as an active element trapping the acoustic energy. The inventors herein have observed a strong relationship between decreased resonator thickness and motional impedance. Double-sided and single-sided filter devices based on the same principles are also provided.